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(71) Applicant *(for all designated States except US)*: COVENTRY UNIVERSITY [GB/GB]; Priory Street, Coventry CV1 5FB (GB).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: PRATT, Christopher, John [GB/GB]; Coventry University, School of the Built Environment, Priory Street, Coventry CV1 5FB (GB).

(74) Agent: HALLAM, Arnold, Vincent; Lewis & Taylor, 5 The Quadrant, Coventry CV1 5FB (GB).

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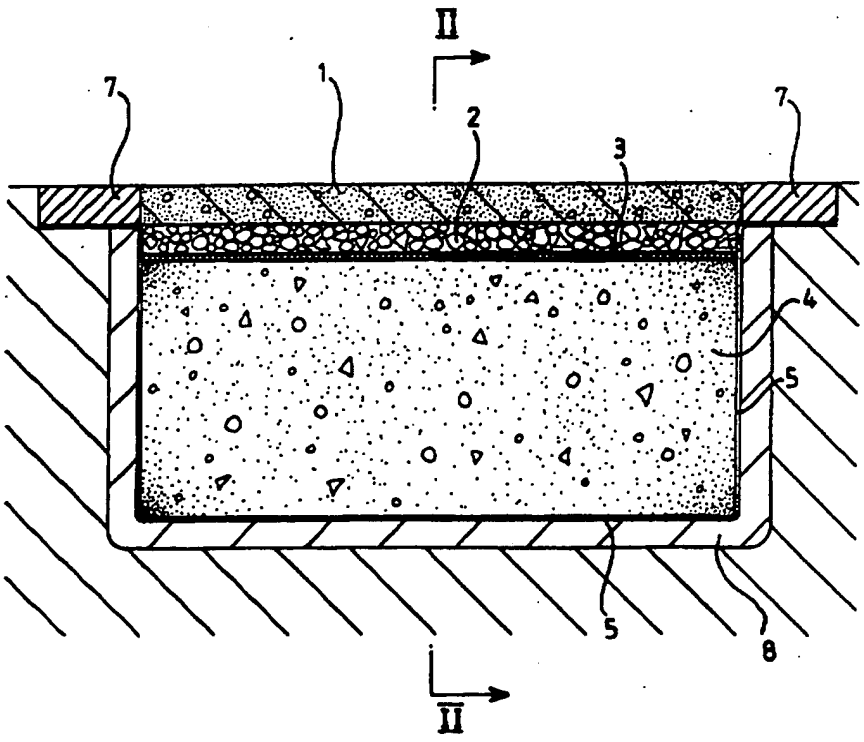
(54) Title: PAVING SYSTEM FOR SPILLAGE AND FLOOD MANAGEMENT

(57) Abstract

The paving system has a perforated pavement (1) covering a deep substrate of mainly hard nodules or shells, the whole being surrounded by impervious walls (5) to provide temporary storage in the interstices for chemical spillage or flood water, wherein liquids may be chemically treated or biologically decomposed, and whence the rate of outflow may be regulated. The pavement may consist of preformed pavings of brick, concrete or other material, laid edge to edge without mortar or cement. These pavings may be perforated or notched to allow liquids to run down into the substrate. The pavings are laid on a screen (2, 3) which filters out solid particles to stop the system clogging. This system allows biological substances to grow, or be introduced with or without additional nutrients, or chemical treatments to be introduced, from above, when needed. The whole pavement system can be lifted out for cleaning or substitution, and relaid as new.



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Paving System for Spillage and Flood Management

This invention relates to a system of construction for paved surfaces.

Paved surfaces are required in many situations where the impermeability of a conventional pavement is essential, but not without disadvantages. In some situations - refuelling stations, chemical loading bays and vehicle parks, for instance - there may be risk of spillage of fluids which must be prevented from entering the drainage system and so passing by uncontrolled discharge into the environment, and must be prevented from entering the environment at all without preliminary treatment.

Where there are large areas of pavement - motorways, for instance - flash storms may cause such flooding that existing storm-water provisions become overloaded. There have been occasions, too, when emergency treatment of spillage after accidents involving chemical tankers has resulted in serious damage to the environment over wide areas.

Where risks of chemical contamination are low, various forms of porous pavement have been employed, allowing spillage to soak away into the ground beneath. There is, however, a limited rate at which ground can absorb moisture, and there remains a risk of flooding when rainfall is very high.

According to the present invention, there is provided a paving system having a plurality of layers comprised by:

a first layer permeable to liquid;

a second, substrate layer of particulate material below said first layer for supporting said first layer and receiving liquid permeating through said first layer;

and a third layer impermeable to said liquid for retaining said liquid in said second layer.

In a preferred form of the invention a fourth layer is provided intermediate the first and second layers for filtering solids from liquid permeating through the first layer, and a fifth layer is located intermediate the first and fourth layers for dispersing liquid permeating from the first layer over the fourth layer.

The first layer is conveniently perforated to allow the liquid to run through into a tank or channel formed by the third layer.

The first layer, which forms the pavement may be a single sheet laid or cast over the whole of, or a large section of, an area, in which the perforations may conveniently be simple holes. However, it is advantageous to have holes of small span to stop ingress of foreign objects, but of long periphery to facilitate dispersion of the fluid underneath the pavement. Slot-like holes are therefore attractive, and these can conveniently be provided by grooves on the outside of prefabricated pavings.

In a further preferred arrangement, the pavement may be formed by pavings of such size and mass as to be convenient to handle continually without fatigue, and designed to be laid close-fitting without mortar or cement. They may be made in any material suitable for any particular application, such as brick, concrete, or cast iron, and must be of sufficient depth to ensure dispersion of the concentrated loads applied. Concurrently, they are of sufficient depth to prevent them tipping over under load, given the lateral freedom allowed by close-fitting laying. Pavings may have holes through them, but from many points of view it is preferable that the perforations be grooves in the interfaces separating adjacent pavings. Paviours find this type of pavement cheap and easy to lay, with the further advantage that pavings can easily be lifted when required.

The incorporation of raised pads on the upper surfaces of at least some of the pavings prevents compression of the gravel filling around the paving and reduces the danger of

hydroplaning in storm conditions, and is a preferred feature.

Underneath the pavings, the fourth layer is a geotextile layer used to filter out unwanted solids. This is preferably between 1mm and 1.5mm thick.

The pavings are laid on a bed of gravel or crushed gravel or other small grained particulate material (the fifth layer) which covers the geotextile layer, and the same or similar material is dropped into the perforations and around the raised pads. The layer is a material which is not readily fryable, dissolved or susceptible to frost and is substantially inert to water. The particle size is preferably of a minimum 5mm diameter to a maximum of 10mm diameter. The particle size may vary within the above range in the layer.

This particulate layer provides a flat surface for the pavings and ensures that the geotextile layer is uniformly loaded. Moreover, it helps to disperse the fluid from the perforations uniformly over the surface of the geotextile layer, and provides an initial screening of the fluid to minimise clogging of the geotextile layer beneath. The particulate infill provides a relatively smooth surface for humans and animals to walk on, and is easily weeded when necessary.

Beneath the geotextile layer is the substrate proper (the second layer) which lies on, and is contained by, the impermeable membrane described above. This is a deep layer of mainly hard nodules. These could be hollow, and there may be advantage in some being hollowed out or drilled as described below, but they are most efficient when solid. They are preferably of irregular or lobate form so that they remain firmly in place under load but are surrounded by interstitial cavities in which the drained fluid can dwell.

These nodules may be of any suitable material: crushed stone, pebbles and blast furnace slag are typical examples, but special materials or shapes may be needed in particular applications. The size and type of nodule affects the storage and release capabilities of the paving system. The material used for the substrate is also a material which is not readily

friable, dissolved or susceptible to frost. It is also substantially inert to water. The material can consist of particles of differing sizes in the range 15mm to 200 to 300mm and the particle size may vary within the second layer. However, the majority of particles in the materials should be of a size nearer the lower end of this range.

This system ideally meets the requirements for biological decomposition of certain types of harmful spillage. Bacteria breed on the substrate walls if spillages are not infrequent, and fresh cultures or cultures of different bacteria can be introduced into the substrate cavities when needed. It may be advantageous to provide 'nests', perhaps in porous or hollow nodules, in which suitable bacteria can breed awaiting the next spillage. It may be necessary in some cases to provide nutrient occasionally to ensure that the bacteria do remain available. Cultures and nutrient can be introduced from above the pavement when necessary without disturbing the pavement.

Chemicals also may be introduced in this way for spillages that are not amenable to biological treatment.

It is an important advantage of this construction that all its elements can easily be lifted out for examination, flushing or other cleaning, or substitution if needed, and the geotextile member can be replaced when it is clogged.

Weirs or dividers can be introduced into the substrate to isolate sections of the tank or channel, either for floodwater control in sloping channels or to allow chemical or biochemical treatment of spillage. Such weirs might be built within the permeable membrane, but there may be advantage in some cases in embedding a smoothly grooved U-shaped component into the ground before the impermeable membrane is laid, and then sliding a pre-fabricated mating weir into position within the membrane lying over the U-shaped component, or sealingly attached to it, to trap the membrane without damaging it. Depending on the application, weirs may be porous, as for floodwater control, or impervious, as for chemical or biochemical treatment of spillages.

Where the cavity within the impermeable membrane is compartmentalised by end closures or impermeable weirs there will be need for valves and discharge ducts for drainage. The provision of the valves and ducts that are sealingly connected to an impermeable membrane is well understood by those skilled in the art and need not be considered here.

This ability to process spillages in situ is regarded as a highly desirable feature of the newly invented system described here. Appropriate chemicals can be admitted into specific containment sections so that hazardous fluids are rendered harmless before they are diluted in more general effluent systems. Added chemicals may themselves be hazardous or harmful in some instances, so by treating the spillage in exact proportions in isolation the overall damage can be minimised. It is much more difficult to do this when the spillage has already been muddled up with fluids from other sources.

The present invention is further described hereinafter, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 shows a transverse cross-section on the line 2-2 of Figure 2 through one embodiment of a paving system according to the present invention;

Figure 2 shows a longitudinal cross-section on the line 1-1 of the system of Figure 1; and

Figure 3 illustrates a typical paving suitable for use in this paving system.

Referring to the drawings:

Pavings 1 are laid on a bed of gravel as shown at 2, and underneath this bed of gravel is a geotextile layer shown at 3.

A substrate of crushed stone is shown at 4.

The impermeable plaster membrane is shown underneath the substrate at 5 and up the sides of the duct. The top of the impermeable membrane is trapped in this case under border stones as shown at 7.

A suggested U-frame used to retain a divider in the form of a weir 9, is shown at 8.

The weir fits inside the U-frame 8. Here, the impermeable membrane 5 is shown trapped between the weir 9 and the U-frame 8. The weir relies upon the support given by the substrate 4. The weir 9 may extend at least a portion of the height of the substrate 4.

A difference in fluid levels on the two sides of the weir 9 is indicated by the two arrows at 10, and a drain valve and outlet pipe is indicated at 11. Since the weir is always at the lowest point of any containment, the valve mounting could be included in the U-frame 8, but it is shown discrete here for clarity.

Claims:

1. A paving system having a plurality of layers comprised by:

a first layer (1) permeable to liquid;

a second, substrate layer (4) of particulate material below said first layer for supporting said first layer and receiving liquid permeating through said first layer;

and a third layer (5) impermeable to said liquid for retaining said liquid in said second layer (4).

2. A paving system as claimed in claim 1 further comprising a fourth layer (3) intermediate said first and second layers (1,4) for filtering solids from liquid permeating through said first layer (1).

3. A paving system as claimed in claim 2 further comprising a fifth layer (2) intermediate said first and fourth layers (1,3) for dispersing liquid permeating from said first layer (1) over said fourth layer (3).

4. A paving system as claimed in claim 3 wherein said fifth layer (2) is of particulate material.

5. A paving system as claimed in claim 4 wherein said fifth layer (2) is formed of a material which is non-fryable and non-susceptible to frost.

6. A paving system as claimed in claim 4 or 5 wherein the average size of the particles of said fifth layer (2) is smaller than that of the particles of said second layer (4).

7. A paving system as claimed in claim 4,5 or 6 wherein the particles of said fifth layer

(2) have a diameter in the range 5mm to 10mm.

8. A paving system as claimed in any of claims 2 to 7 wherein said fourth layer (3) is a geotextile layer.

9. A paving system as claimed in claim 8 wherein said geotextile layer has a thickness in the range 1mm to 1.5mm.

10. A paving system as claimed in any of the preceding claims wherein said second layer (4) is formed of a material which is non-fryable and non-susceptible to frost.

11. A paving system as claimed in any of claims 1 to 10 wherein the particle size of said second layer (4) is in the range 15mm to 300mm with particles predominantly being of a size nearer the lower end of the range.

12. A paving system as claimed in claim 11 wherein the particle size of said second layer (4) is in the range 15mm to 200mm with the majority of particles having a size towards the lower end of the range.

13. A paving system as claimed in any of the preceding claims wherein said first layer (1) is provided with slot-like holes for enabling permeation of liquid through said layer.

14. A paving system as claimed in claim 13 wherein said first layer (1) is formed by a plurality of pavings having lateral, abutting surfaces and wherein each paving is provided with at least one groove in at least one of said abutting surfaces, each said groove extending the thickness of said paving thereby to form said slot-like holes.

15. A paving system as claimed in any of the preceding claims wherein said first layer (1) is provided with perforations to enable permeation of liquid through said layer.

16. A paving system as claimed in any of the preceding claims wherein said third layer (5) is a layer of plastics material.

17. A paving system as claimed in any of the preceding claims wherein said paving system is divided into a plurality of discreet, horizontally extending portions by at least one divider means (9) extending from said third layer (5) at least a portion of the height of said second layer (4), said divider means being impermeable to said liquid thereby to prevent passage of said liquid from one portion of said system to another.

18. A system as claimed in claim 17 wherein the or each said divider means extends the height of said second layer (4).

19. A system as claimed in claim 17 or 18 wherein said third layer (5) is formed as an elongate channel having a base portion and side portions, wherein:

each side portion of said third layer (5) extends from said first layer (1);

and the or each said divider means (9) extends the full width of the channel.

20. A system as claimed in any of claims 17 to 19 wherein the or each said divider means (9) is supported by a respective support member (8), said third layer (5) being retained between said support member (8) and said divider means (9).

21. A system as claimed in claim 20 wherein said support member (8) is substantially U-shaped having an inner groove extending the length thereof thereby slidingly to receive said divider means (9).

22. A system as claimed in any of the preceding claims further comprising means (11) for enabling the draining of the liquid through said third layer (5).

23. A system as claimed in claim 22 wherein said draining means comprises a valve means.

24. A system as claimed in any of the preceding claims wherein said first layer (1) is formed by discreet pavings at least some of which are provided with raised pads on an upper surface thereof.

25. A paving system as claimed in any of the preceding claims further comprising means for enabling gas to be drawn through at least said second, substrate layer (4).

26. A paving system as claimed in claim 25 wherein said gas is atmospheric air.

27. A paving system as claimed in claim 25 wherein said gas is substantially oxygen or carbon dioxide.

28. A paving system as claimed in any of the preceding claims wherein the particles of said second layer are of irregular shape thereby to provide interstitial cavities therebetween in which said liquid can dwell.

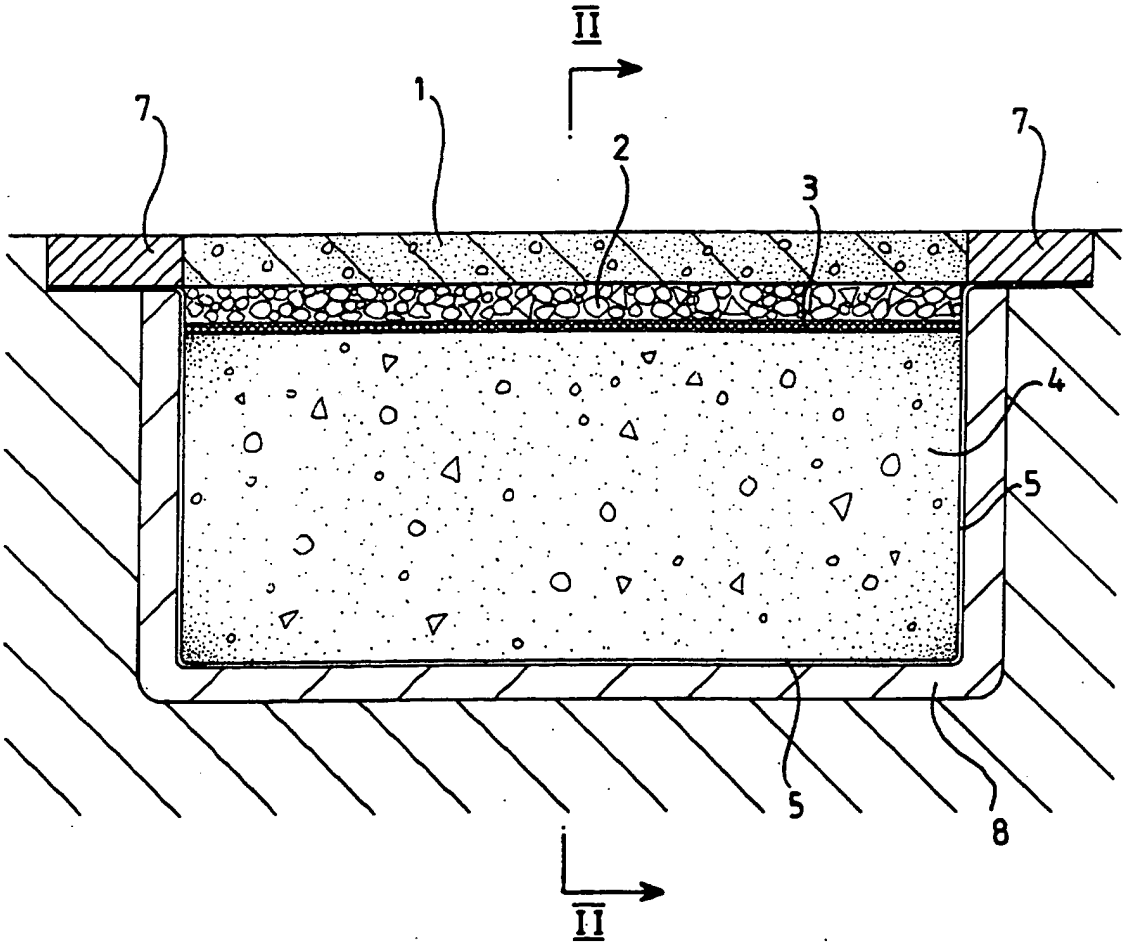
29. A paving system as claimed in claim 28 wherein said particles are of lobate form.

30. A paving system as claimed in any of the preceding claims wherein particles of said second layer are porous or hollow.

31. A paving system as claimed in any of the preceding claims arranged to enable the biological decomposition by bacteria of pollutants in said second layer.

32. A paving system substantially as hereinbefore described with reference to the accompanying drawings.

FIG 1



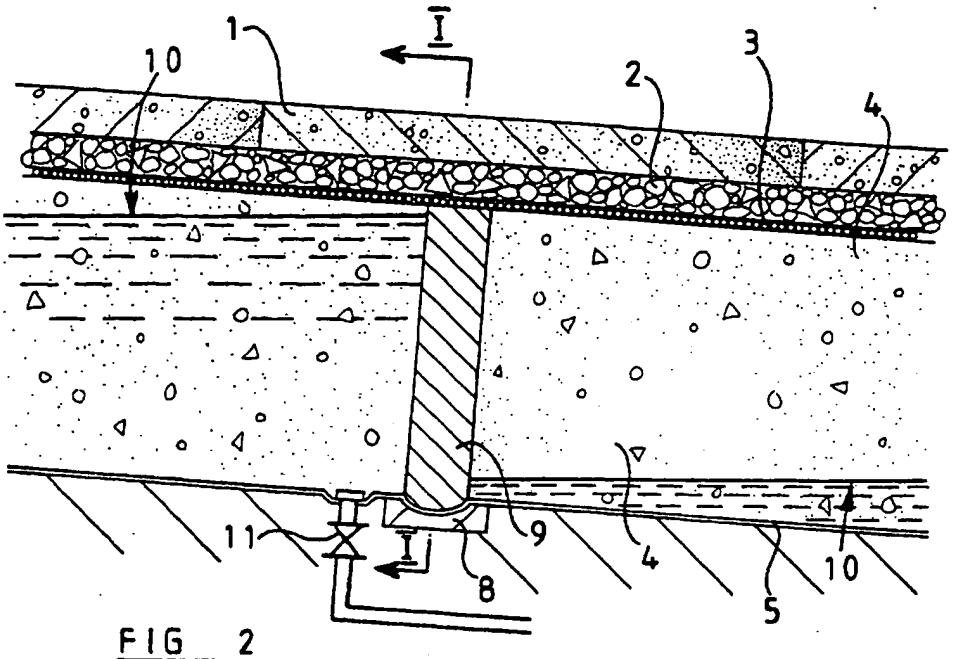


FIG 2

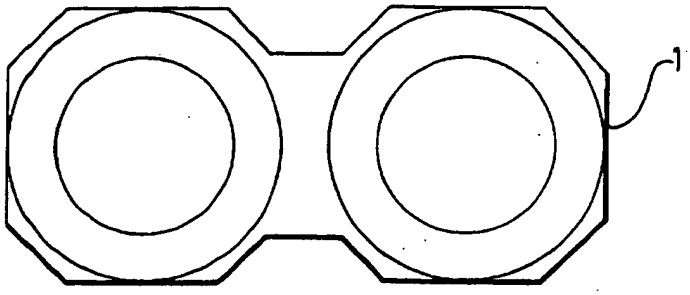


FIG 3

INTERNATIONAL SEARCH REPORT

Interr al Application No
PCT/GB 95/02434

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 E01C3/06 E02D31/00 E03F1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 E01C E02D E03F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	see the whole document	25,26
Y	DE,A,40 17 115 (HUSU AARNE) 20 December 1990 see abstract; figure 1	25,26
X	DE,U,93 16 175 (HAUG MANFRED) 10 March 1994	1,10-12, 16,22, 28,32
Y	see the whole document	2-6,8, 13-15, 17,19, 24-26,31

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
9 January 1996	23. 01. 96

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

information on patent family members

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